Performance-Based Acceptance vs. Performance-Based Design

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Thank you to NCAT for their willingness to share slides from their BMD Workshop in my development of this presentation.
Performance-Based Acceptance

Quality Assurance (QA)

“all planned and systematic actions necessary to provide confidence that a product or facility will perform satisfactorily in service. QA includes the elements of quality control (QC), acceptance, independent assurance, dispute resolution, laboratory accreditation, and personnel certification.”
Quality Control (QC)

“the system used by the contractor to monitor, assess and adjust their production or placement processes to ensure that the final product will meet the specified level of quality. QC includes sampling, testing, inspection, and corrective action (where required) to maintain continuous control of a production or placement process.”

Acceptance

“the process whereby all factors used by the agency (i.e. sampling, testing, and inspection) are evaluated to determine the degree of compliance with contract requirements and to determine the corresponding value for a given product.”
Performance Testing in QA

- Performance Tests (PT) should be conducted on plant produced mix and results used in acceptance decisions much like lab compacted air voids are currently used.
- Other pay factors may still include properties such as %AC, in-place density, and joint density (and smoothness for the final layer).
- Need to establish reasonable acceptance limits for PT results considering test precision. Will you use agency results for acceptance or “validated” contractor data?
- Need to establish suitable frequencies of tests.

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Performance Testing in QA

- Timeliness of QA results is critical.
- Most plants produce 200-400 tph. If results take 4 hours to complete the tests, then 800 to 1600 tons of mix have been produced during that time.
- The cost of that mix would be $50k to $150k.
Lab Produced vs. Plant Produced Mixtures

- Changes in binder source / properties
- Changes in the aggregate properties
- Breakdown of aggregate through the plant
- Incomplete drying of aggregates
- Variations in baghouse fines return
- Differences in aging and absorption
- Inaccurate plant calibration
- Different laboratory equipment
- Different technicians
- Changes made to mix proportions

Challenges Associated with Performance-Based Acceptance

- Testing defensibility
  - Timely results
  - Test repeatability
    - Cracking tests
    - Field vs. lab produced specimens
  - Basically, want quick and reliable
- Laboratory setup
  - Do most labs have testing capability?
  - Can the labs handle testing load?
Performance-Based Design

Balance the Mix Design

Strength/Stability  Smooth Quiet Ride
Rut Resistance     Skid Resistance
Shoving
Flushing Resistant

Durability
Crack Resistance
Raveling
Permeability

DON’T ATTACK ONE HALF AT THE EXPENSE OF THE OTHER HALF!!
### History of Mix Design

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1890</td>
<td>Barber Asphalt Paving Company</td>
<td>Asphalt cement 12 to 15% / Sand 70 to 83% / Pulverized carbonite of lime 5 to 15%</td>
</tr>
<tr>
<td>1905</td>
<td>Clifford Richardson, New York Testing Company</td>
<td>Surface sand mix: 100% passing No. 10, 15% passing No. 200, 9 to 14% asphalt. Asphalyclic concrete for lower layers, VMA terminology used, 2.2% more VMA than current day mixes or ~0.9% higher binder content.</td>
</tr>
<tr>
<td>1920s</td>
<td>Hubbard Field Method (Charles Hubbard and Frederick Field)</td>
<td>Sand asphalt design with compression test (performance) asphaltic concrete design (Modified HF Method)</td>
</tr>
<tr>
<td>1927</td>
<td>Francis Hveem (Caltrans)</td>
<td>Surface area factors used to determine binder content; Hveem stabilometer and cohesionmeter used. Air voids not used initially, mixes generally drier relative to others, fatigue cracking an issue.</td>
</tr>
<tr>
<td>1943</td>
<td>Bruce Marshall, Mississippi Highway Department</td>
<td>Refined Hubbard Field method, standard compaction energy with drop hammer. Initially, only used air voids and VFA, VMA added in 1962; stability and flow utilized.</td>
</tr>
<tr>
<td>1993</td>
<td>Superpave</td>
<td>Level 1 (volumetric), Level 2 and 3 (performance based, but never implemented).</td>
</tr>
</tbody>
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### What Should Have Happened with Superpave...

- Superpave called for Level 1, 2, and 3 testing based on traffic load.
- Level 1 (Volumetrics + TSR) was only for up to around 1 million ESALS.
- Level 2 and 3 were to be used for higher traffic loads and included rutting and cracking performance test.
- Since we saw such good performance (with materials in 1993-2000), Levels 2 and 3 were soon forgotten.

**Balanced Mix Design Basic Concept**

- **Volumetric Criteria**
- **Rutting Criteria**
- **Cracking Criteria**

Remember Superpave Levels 2 & 3?

**Target area of balanced performance**

**Balance Mix Design Drivers**

- **Rutting?**
  - NO
  - Generally not a widespread distress since Superpave implementation

- **Cracking?**
  - YES
  - Various cracking distresses have increased nationally

- **Durability?**
  - YES
  - Related to cracking, durability concerns have been noted
**Balanced Mix Design Goals**

- Ensure pavement performance
  - Rutting
  - Cracking
  - Durability
- Enable innovation
  - Materials
  - Specifications
- Optimize economics

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**Performance Tests**

- Used to access a mixture’s ability to combat or resist specific distresses.
  - Permanent deformation
  - Cracking
    - Reflective
    - Temperature-related
    - Fatigue
  - Moisture damage
Balance Mix Design Keys

• AASHTO PP 105
  ◦ Four approaches
  ◦ Condition specimens
  ◦ Test for differing distress types
  ◦ Consider
    • Aging
    • Traffic
    • Climate
    • Layer

Performance Asphalt Design Approach in USA (2021)

https://www.asphaltpavement.org/expertise/engineering/resources/bmd-resource-guide/implementation-efforts
Rutting Performance Testing Options

- Hamburg Wheel Tracking Test
  - Most common choice
  - Used in eight BMD states
  - Generally gaining popularity (BMD and non-BMD states)

- Asphalt Pavement Analyzer
  - Used by two states
  - Generally loosing popularity (BMD and non-BMD states)

- Hot Indirect Tension Test
  - Used in Alabama only for BMD
Cracking Performance Testing Options

- Eight test procedures currently reported
- Two tests most common
  - I-FIT test
  - IDEAL-CT
- Six states report two cracking tests are required
Where we are going

• Interest in BMD approaches growing significantly
• Multiple combinations of design approaches and testing requirements being seen
• Likely tends that BMD will instigate (Dave’s opinions)
  ◦ Increases in binder contents
    • Mitigates cracking and durability concerns
  ◦ Less reliance on volumetrics
  ◦ Greater reliance on laboratory performance testing during design
• Innovations
  • Rejuvenators
  • Alternative materials

Thank You Asphalt Institute Membership